

# TIME AND FREQUENCY ACTIVITIES AT THE JHU APPLIED PHYSICS LABORATORY

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## Abstract

*The Time and Frequency Laboratory at the Johns Hopkins University Applied Physics Laboratory (JHL/APL) provides support to multiple current and upcoming NASA/APL missions that span our solar system from the study of the Sun's coronal mass ejections to the examination of the outer planets and the Kuiper Belt objects. This support includes providing precise time and frequency to the integration and testing of new hardware, frequency reference for spacecraft ranging and communications via the APL satellite communications facility, and the time-stamping of ground-receipt telemetry packets from various spacecraft. The Lab's ensemble of three high-performance cesium standards and three hydrogen masers are integrated to form the APL timescale, which is the basis for estimating UTC – UTC (APL) and for evaluating the performance of our clocks. Traceability to USNO, NIST, and UTC is maintained via GPS common-view and all-in-view time transfer. The Lab's clocks are also incorporated into the computation of International Atomic Time (TAI).*

## Mission

Provide precise time and frequency in support of critical APL projects and maintain traceability to U.S. and international timing laboratories.

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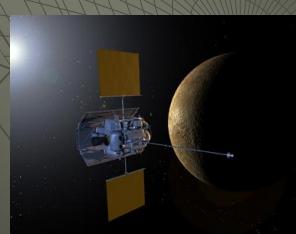
## APL Time and Frequency Lab



## APL Space Science Missions

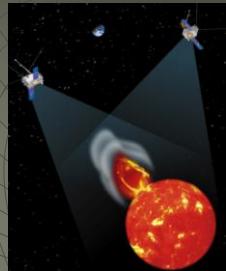


- ◆ TIMED – **T**hermosphere **I**onosphere **M**esosphere **E**nergetics and **D**ynamics



- ◆ MESSENGER – **M**ERCURY **S**urface, **S**pace **E**Nvironment, **G**Eochemistry, and **R**anging

## APL Space Science Missions (continued)



- ◆ STEREO - **S**olar **T**Erestrial **R**Elations **O**bservatory



- ◆ New Horizons

## Lab Facilities

- ◆ Located in standard laboratory room
- ◆ Temperature maintained at 68 degrees +/- 3 degrees Fahrenheit
- ◆ Humidity maintained at 60% maximum
- ◆ AC power is on building UPS plus local UPS for critical systems

## Time and Frequency Lab Hardware

- ◆ 4 Hydrogen Masers
- ◆ 3 High Performance Cesium Standards
- ◆ 5 MHz measurement system
- ◆ 1 PPS clock monitor system
- ◆ 2 Microphase-steppers
- ◆ 1 High Resolution Offset Generator
- ◆ 2 GPS Time Transfer Receivers

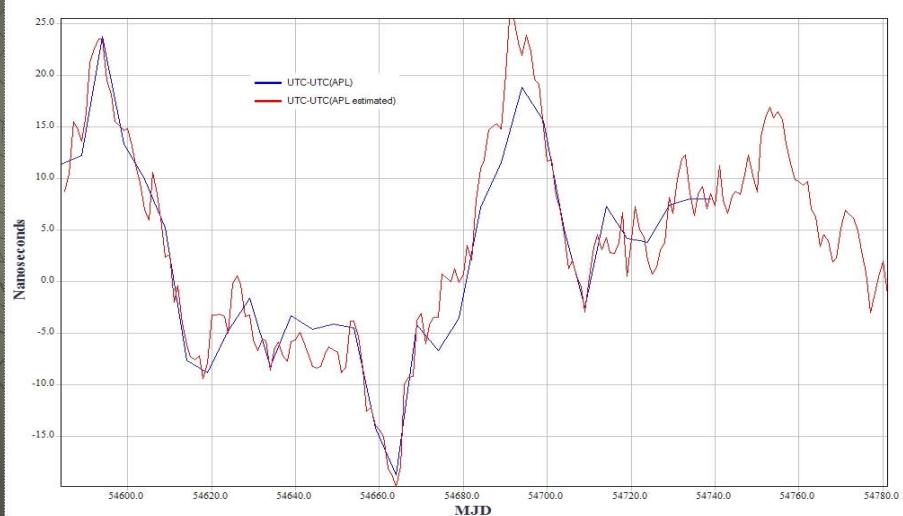
## Time and Frequency Dissemination

- ◆ 1 MHz, 5 MHz, 10 MHz, 100 MHz
- ◆ 1 PPS
- ◆ IRIG-B APL Local Time
- ◆ IRIG-B UTC
- ◆ Common View GPS Time Transfer
  - NIST, USNO, BIPM

## UTC(APL)

- ◆ Output of a Microphase-stepper
- ◆ Microphase-stepper driven by a High Performance Cesium
- ◆ Microphase-stepper adjustments are based on estimate of UTC-UTC(APL)
- ◆ Adjustments are made as needed

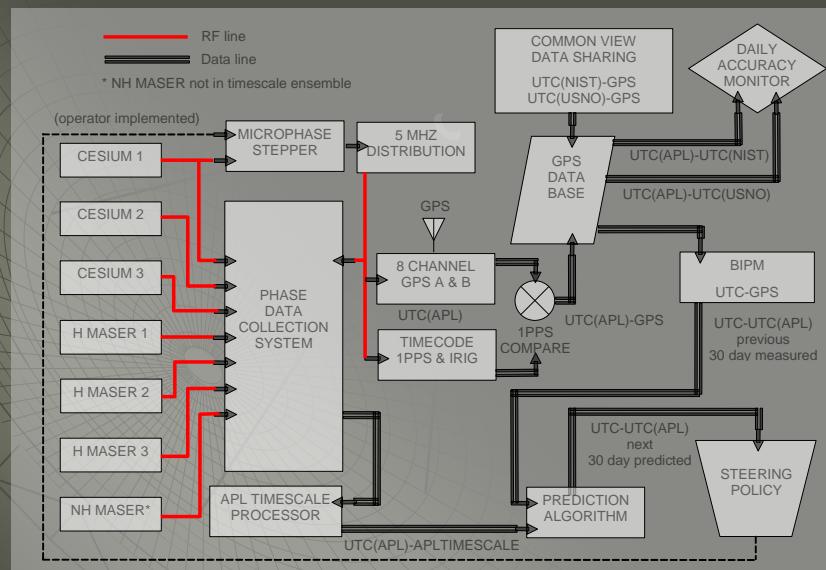
## UTC – UTC(APL) & UTC – UTC(APL estimated)



## APL Timescale

- ◆ 3 Hydrogen Masers
- ◆ 3 High Performance Cesiums
- ◆ Clocks are equally weighted
- ◆ Referenced to UTC(APL)

## APL Timekeeping System

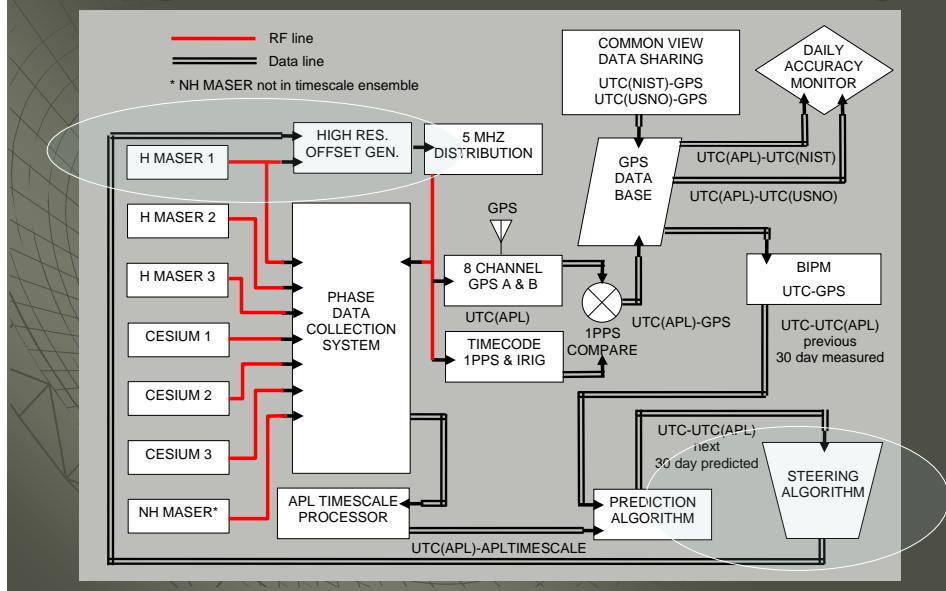


Note: In above slide, “NH MASER” should be “NR MASER”

## Future Improvements

- ◆ UTC(APL) will be the output of the Offset Generator (Dec. 2009)
- ◆ Offset Generator will be driven by a hydrogen maser (Dec. 2009)
- ◆ Offset Generator adjustments will be automated and made daily based on estimation of UTC-UTC(APL) (Dec. 2009)
- ◆ T&F Lab move to New Space Department building (2011)

## Upgrade to Automated Steering



*41<sup>st</sup> Annual Precise Time and Time Interval (PTTI) Meeting*